Sound, Beats and Resonance

Sound is vibrations of molecules that we can hear. Range is about 20-20 000Hz (I max out at 14 kHz)
http://www.noiseaddicts.com/2009/03/can-you-hear-this-hearing-test/
Longitudinal waves - they can't be polarized
An oscilloscope can be used to observe the sound waves as transverse waves.

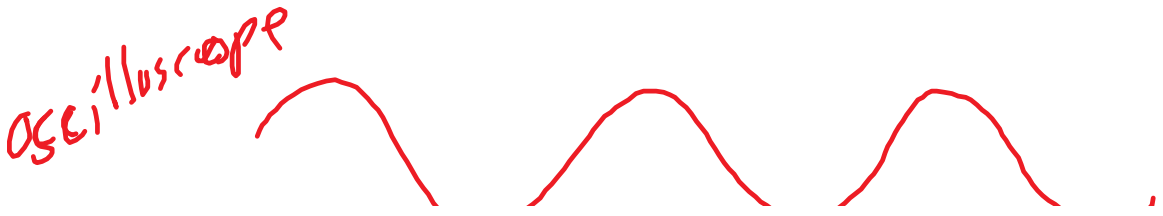
Pitch of a sound is related to the frequency, higher pitch is higher frequency.

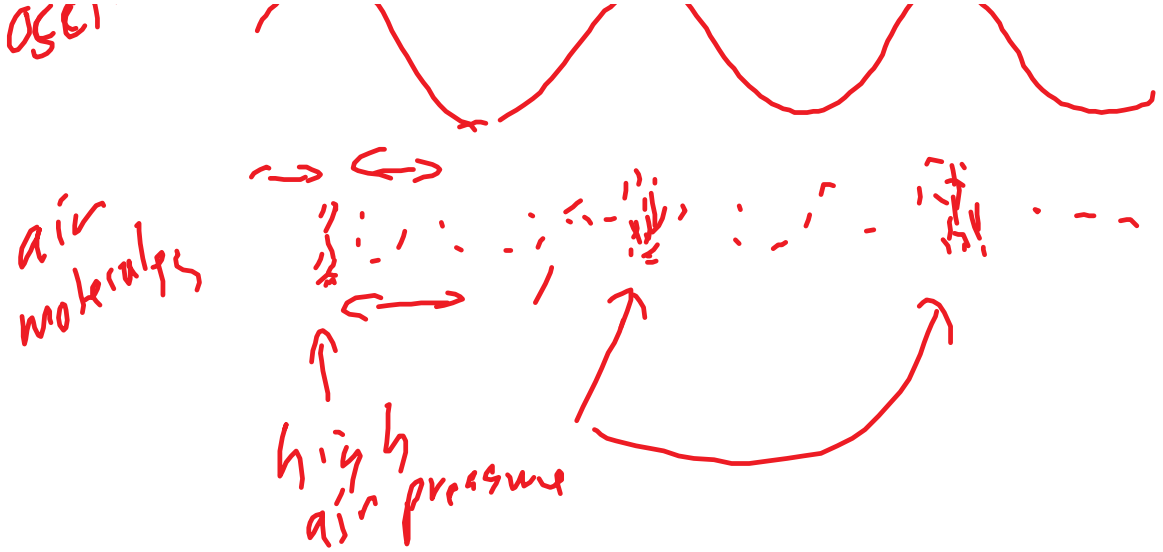
When sounds combine a new waveform is produced.

Our voices are a combination of many frequencies at various amplitudes.

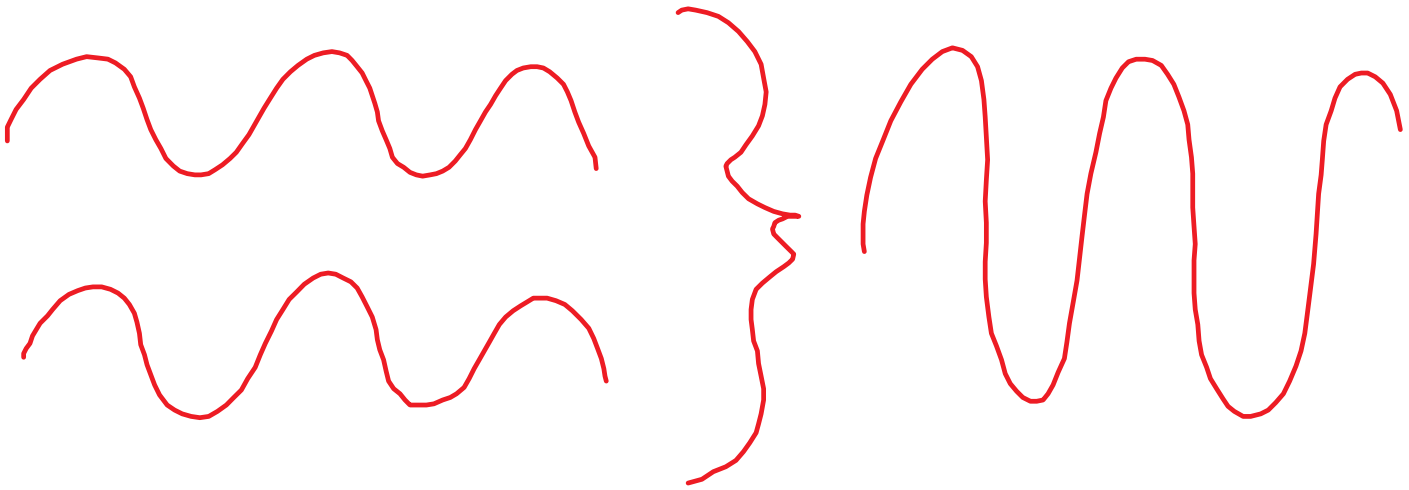
complex waveform

A tuning fork or a whistle produce a sine wave.



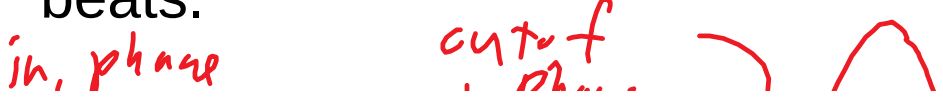


If there are two sets of waves in phase with identical frequencies, a larger wave is produced.



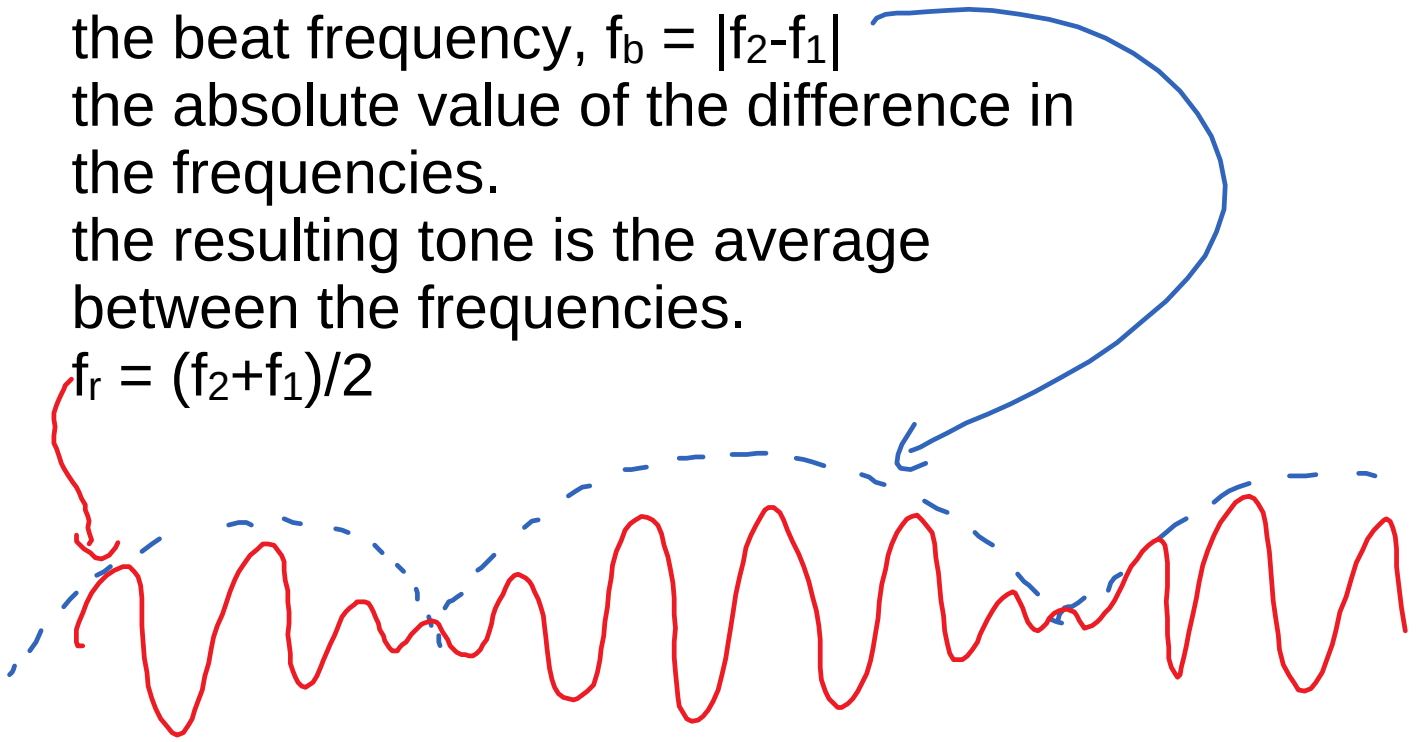
If they are the same frequency but out of phase, they can cancel out. (double slit experiment)

If they are almost the same frequency, they alternate being in phase and being out of phase, - you hear "wah wah" sound, called beats.



beats:

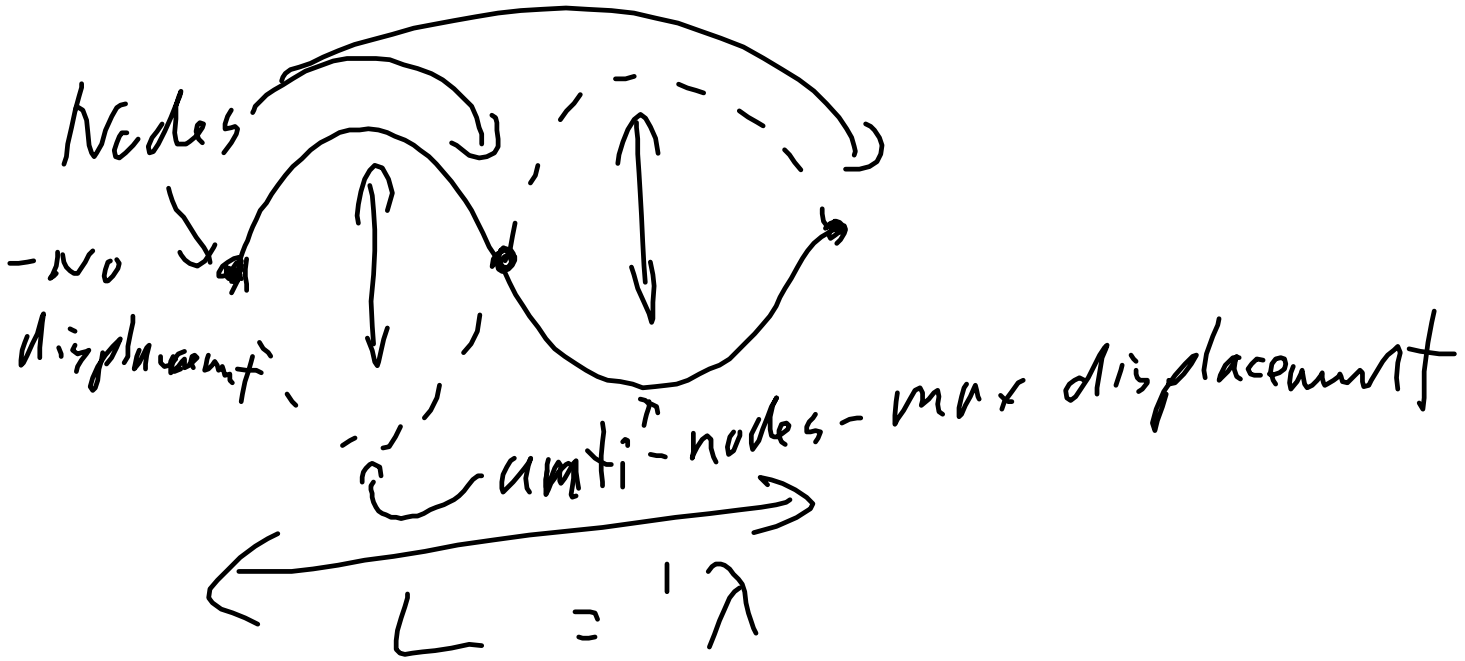
the beat frequency, $f_b = |f_2-f_1|$
the absolute value of the difference in the frequencies.
the resulting tone is the average between the frequencies.
$f_r = (f_2+f_1)/2$

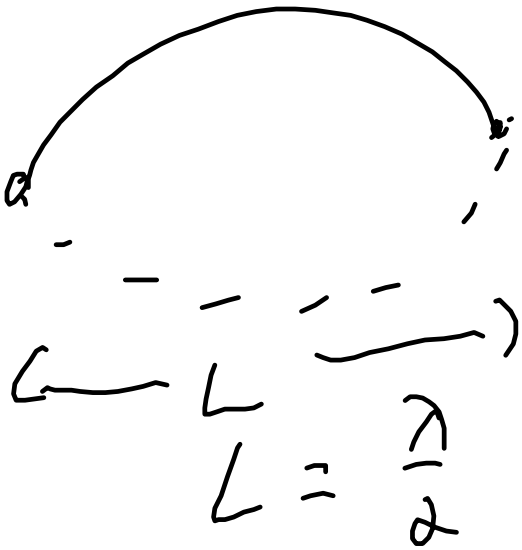


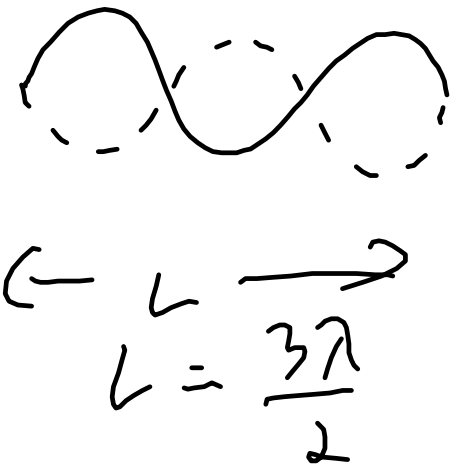
Standing waves
If the waves bounce back, the incoming waves interfere with the reflected waves.

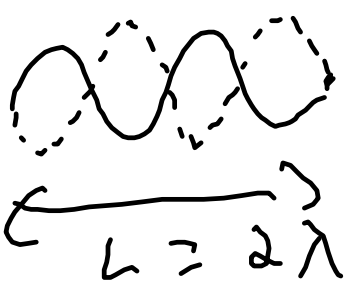
If the frequency is just right, the resonant frequency, high amplitude standing waves are produced.

What is the relationship between the wavelength, the speed of the wave, the resonant frequency and the length of the string or tube?









$$L = \frac{N\lambda}{2}$$

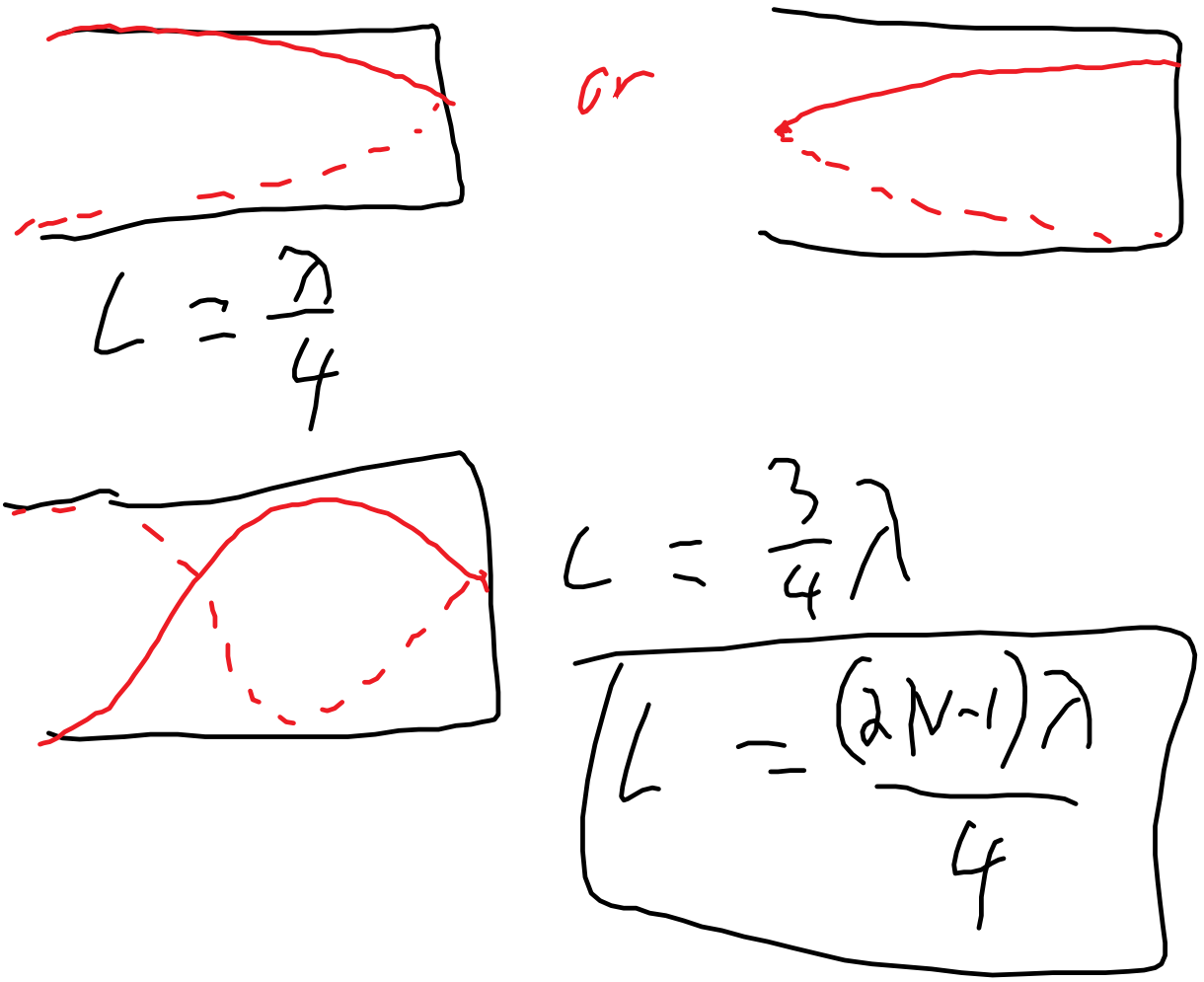
N is whole number

- number of resonance

Harmonic = N-1

that is the equation for a string or tube that is open or closed at both ends.

What about a tube that is closed at one end, or a string that is loose at one end but held at the other?



1. A 440Hz tuning fork is in air with air speed of 340 m/s (3 sig figs for everything)

a) what is the wavelength of the sound?

b) if another tuning fork is near and you hear 5.0 Hz beats, what is the frequency of the other fork?

c) if the 440Hz fork is brought near a closed tube, at what 2 first lengths will you hear resonance?

d) If you hear resonance at 21cm and 60 cm, what is the end correction of the tube?

Hecht p433-434

- Q 101, 103, 111, 114

a) $v=\lambda f \quad =\lambda = v/f = 340m/s/440 = 0.773m$

b) either 435 or 445Hz

c) $L=(2N-1)\lambda /4 = \lambda/4$ for the first and $3\lambda/4$

= 0.773/4=0.1933 and

3x(0.773)/4=0.5798

19.3cm and 58.0cm

d) 2 cm off but usually the end correction is outside the tube, in the lab you might expect the values to be 17cm not 21cm
https://phet.colorado.edu/sims/html/wave-on-a-string/latest/wave-on-a-string_en.html
http://www.walter-fendt.de/ph14e/stwaverefl.htm